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ABSTRACT

Used as an additional aid by the teacher, microelectronics can assist mentally and physically handicapped children to meet educational objectives that have been specifically agreed upon for the individual child. Microelectronics can help deaf children develop speech production, communication skills, and grammar and sentence construction; accommodate blind children with the use of portable reading aids, Braille and audio information centers, and text-processing systems; aid children with learning difficulties to develop thinking skills; and provide physically handicapped children with a means of accessing a variety of computer-assisted instructional (CAI) learning programs. It is difficult, however, to use microcomputers in helping non-communicative children who use Bliss symbols because of the difficulty in obtaining software, the amount of planning time and effort needed to use the software appropriately, and the lack of special technical support. Activities funded by the Microelectronics Education Programme (MEP) in which the Council for Educational Technology (CET) has been involved include: curriculum development for deaf students; training for teachers, other staff, and parents of physically handicapped children; Special Education Microelectronics Resource Centres; consultancy centers on communication aids in education; and research on input/output devices software for the physically handicapped. Further reading resources are listed. (DJR)

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MICROELECTRONICS AND SPECIAL EDUCATION

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Introduction

Technological advances are starting to open up new educational opportunities for mentally and physically handicapped children. A welcome additional boost to this trend is the inclusion within the Microelectronics Education Programme for England, Wales and Northern Ireland and the Scottish Microelectronics Development Programme of a strand of work devoted to exploiting micro-electronics for the benefit of special education. There is no doubt that there is a lot of potential for providing new and exciting learning opportunities and it is hoped that support from MEP will enable these possibilities, and the enthusiasm of teachers, to be harnessed for the benefit of the children.

This information sheet gives an outline of:-

- some of the possibilities and problems,
- and of the work that is being supported by MEP.

This information sheet and directory should only be regarded as reflecting the state of the art at the time of writing. We hope that the speed of developments will be such that it is soon out of date! (Revisions will be made as necessary.)

The contribution of microelectronics to special education

"Children with special needs" is a wide ranging term which includes those who are physically handicapped, moderately and severely educationally subnormal, maladjusted, blind and partially sighted, deaf and partially hearing, autistic, dyslexic, and those who for some other reason require additional educational provision. We would like to stress that it is additional rather than different.

The contribution of microelectronics is as an additional aid for the teacher and one that must be viewed in the context of the educational objectives that have been agreed for the child. Microelectronic devices and software are part of a learning environment and we need to be clear about why we are using this method and what we are trying to achieve. To derive the best from the new technology it must be used within a framework of educational theory and practice.

Rather than attempt a comprehensive catalogue of ways in which microelectronics can contribute, we will outline some of the possibilities and problems of their use in specific situations.

1 Helping the deaf and partially hearing child

One of the problems for the deaf and partially hearing is in speech production. Programs are being developed (and one is now commercially available) that analyse the speech and give a visual representation. The hearing impaired speaker can then see his speech and modify it to the pattern produced by a hearing person, and thus improve the intelligibility of it. The Speech Display system developed by the RNID displays either pitch (voice fundamental frequency) or energy information. It runs on an Apple microcomputer and costs about £1,800. This price includes the computer and disc drive. It is available from Jessup Acoustics, Unit 5, 7 Long Street, London E 2.

Work on speech comprehension by the deaf by Professor F Fallside at Cambridge University has analysed incoming speech into phonemes. This information is given to the deaf person either symbolically superimposing it on their field of vision, or by electrotactile body or finger arrays. The aim is to make information available for a 'total communication' approach.

Another problem for deaf children is gaining a good working knowledge of grammar and sentence construction. This deficiency results from their lack of exposure to normal communication. Programs are now being developed which require the child to construct a sentence from a jumbled collection of words to describe a picture or slide. As the teacher inputs the words, exercises can be designed to give practice in the use of prepositions/adjectives/verbs, etc.

2 Helping the blind and partially sighted child

Several microelectronic devices are available for the blind. The Otacon is a compact portable reading aid which gives the blind user immediate access to printed material. The user holds a camera in her right hand and moves this over the text. This is analysed by the Otacon and reformatted so that it can be felt and 'read' by the forefinger of the left hand which rests on an array of vibrating rods. It costs about £2,000.

Another aid for the blind is the Versabaille. This is a portable braille and audio information centre for the blind. Information is entered either as sound or braille and can be stored in sections of the cassette tape for ease of access. Editing facilities are available. The output can be in braille on a 20-character tile display. It costs about £2,300. Both the Optacon and the Versabaille have the disadvantage of being relatively expensive but do have the great advantage of being currently available. Details from Mr Ed Vitu, Woodland Cottage, Dunstall Green, Chobham, Surrey.

Blind students will also benefit from developments such as the Braille and Ink-print Text-processing System (BITS) developed by Dr J M Gill at the Warwick Research Unit for the Blind. This enables a typist with no knowledge of braille to produce documents in both ink-print and contracted braille from one typing operation. This would enable a school to produce lecture notes and worksheets in both print and braille. Information from RB Aids for the Blind Ltd, 6A New Street, Warwick CO34 4RX.

3 Helping Children with Learning Difficulties

Children with learning difficulties form the largest group in special education, and includes those who were previously designated ESN(M) and maladjusted.

When the teacher of children with learning difficulties starts to consider the use of a microcomputer, he/she will probably ask some of the following questions:-

- Can a microcomputer help me achieve the educational objectives agreed for these children?
- Has the available software been evaluated?
- How do you choose and pay for the hardware?
- Where do you get and how do you pay for the software?
- How do you generate new material to use on the microcomputer?

With the Department of Industry scheme, the increasing awareness of Local Education Authorities of the importance of microcomputers, and the growing group of computing advisers, we would suggest that the hardware problem is soluble. For more information see CET Information Sheet 1 - "Thinking about microcomputers: First Steps".(1)

The more vital question is the role of the microcomputer in achieving educational objectives. The current emphasis is on using the microcomputer as a "teacher's aid" in teaching the basic skills in literacy and numeracy.

The generally accepted principles of remediation reported by Tansley and Panckhurst (2) are:-

- 1 The need for individualizing the approach.
- 2 The advantages of multi-sensory stimulation.
- 3 The adoption of over learning as a practice, of structured methods with stress on rules and regularities, of methods of ensuring pupils success and of "simple" methods of remediation.

In all these areas the endless patience, the graphics and animation, the variety of consistently delivered reinforcers and the motivating effect of the computer make this a valuable learning tool in the classroom. The large number of programs of this type being produced by teachers is evidence, if it is needed, of its value in this role.

Many of these programs have facilities to enter data that is relevant to the child's needs. eg A program on letter recognition written by Keith Anderson from Goole allows the teacher to enter the 10 letters that the child will work on. Other programs do not have this facility but teachers with some knowledge of programming in BASIC can amend the data statements so the vocabulary relates more closely to the child's other work.

Some teachers are exploring other ways of using the microcomputer which focus more on teaching the child learning strategies and skills in asking questions and using information.

The teacher wishing to use the micro in this way is advised to turn to Seymour Papert's book "Mindstorms" (3) for ideas and inspiration. His approach is to view the computer as a tool for the child to use in exploring the world. For this to be practicable a very simple but powerful programming language is necessary. (A version of this, LOGO, is available on some minicomputers, but a modification usable on the main educational micros has not yet been finalised.) This would enable a child to work out the strategy involved, for instance, in drawing a right-angled triangle and to write a program to do it. Thus, theorems and Euclidian geometry are learned because they have a relevance to a problem faced by the child rather than as a set of rote rules. What is essential is that the programming tools are so easy to use that the emphasis is on thinking out the logical steps and understanding the problem rather than on programming skills per se.

While there is the practical problem of LOGO not being currently available for the micros found in schools, some of the principles can be applied, using a toy such as "Bigtrak". This is a battery-operated toy available from large stores for under £30. It is a six-wheeled tank with an electric motor and what looks like a calculator keypad on top. This is used to "program" the direction and distance of the planned route. As up to 16 instructions can be stored, there is scope for fairly complex manoeuvres that develop and test the child's ability to plan moves logically.

Another example of a simple program that could be used to develop the child's thinking skills is "Animal". This is on the demonstration disc given away with the Apple microcomputers, and a more powerful version has just been developed by the ITMA team at The College of St Mark and St John for the Research Machines 380Z. It asks the user to think of an animal and to ask a series of questions until the computer puts forward a suggestion of the animal it thinks the user has in mind, eg a frog. If the user was not thinking of a frog but, say, of a giraffe, he is requested to feed into the computer a question that will distinguish a frog from a giraffe. This information is added to the program, so that, when it is next run, it has further ways of classifying animals. The ITMA version, which will be available from Longmans in early 1982, enables a child to easily construct a binary classification program such as this in any subject, eg shapes, food, colour etc. This could be used by teachers to get children to develop skills in asking the appropriate questions.

Another program using the computer in the wider curriculum is described by Anthony P Mullan in the October edition of Windfall. (4). "Destroyer" is played between two groups of children and the aim is to find and sink the opposing destroyer. The game is played on an imaginary sea that has islands, mines and bases embedded in it. At each move the children have to decide if they want to move their destroyer, to ask for information, to attack or to employ one of a limited number of spy planes. The educational benefits include a mastery of coordinates, experience of group decision-making and a focus on problem-solving through the formation of strategies.

In these three examples the use of the microcomputer has introduced the child to new learning processes. Michael Weiss, (Schools Council: Communication and Social Skills Project) in an unpublished paper had described how;

"In a primary school in London, a group of pupils gathered around a microcomputer busily tapping away at the keyboard writing a short story. They punched up their story and saw it appear on the video display. They then considered the display. As a group they discussed and changed spellings, punctuation and rephrased some of the lines by punching the appropriate keys. At the press of another button, out came the story on the print-out with a space at the end. In this space they drew a picture and then beamed with satisfaction.

"What the microcomputer allowed these eight year olds to do as to work as a group around a piece of writing and, with a far greater freedom than that experienced with writing on paper, to arrange and redraft their piece of writing. (An equivalent with writing would involve cutting and pasting pieces of paper, using a rubber and still would not achieve this ease of redrafting.) The obvious question that must be asked is, that if children are learning English in this new way, in what way must teaching change to take account of it, and in what way does this change in the composing process (sorting, ordering and bringing coherence to) affect the thinking processes of these youngsters (the way they think about grammar, punctuation, presentation and so on)?"

A further question to ask is "is this an effective way of teaching children literacy skills?" Support for the view that it might be comes from a research finding quoted on p. 234 of "Children with Specific Learning Difficulties" (2):-

"...specific learning difficulty is a learned pattern of behaviour rather than an inbuilt deficiency. Acceptance of that viewpoint - or even of the possibility of its validity - could lead to a change of approach which took the child as carrying the key to his own repair rather than depending on a 'fix-it' model".

The teacher of children with learning difficulties is faced with both theoretical and practical problems. Examples of good educational software are scarce, and none have been evaluated. Some of the reasons for this shortage are explored in an interesting article by Mike Thorne (5). Even locating and acquiring software to teach basic skills still requires contacting several sources. However, a list of software producers for special education is given in the directory attached to this information sheet.

4 Helping a non-communicating child who uses Bliss symbols

Although this might appear to be a highly specific situation, the use of Bliss symbols is widespread in teaching institutions, and this example highlights some of the problems of using microcomputers to help communication.

The system consists of an agreed set of simple symbols which express particular concepts. There are around 1400 such symbols in the current Bliss vocabulary. A mature Bliss user would have a display of about 400 symbols and, where the user can point competently, this will usually be on a simple lap tray. Communication is achieved by pointing in sequence to a number of symbols, meanwhile getting confirmation from the communicant that s/he has understood correctly which symbol has been pointed to.

The difficulties for a teacher in a classroom are clear. Not all speech-impaired children can point accurately, and much effort goes into devising such necessary, but time-consuming techniques as colour coding schemes to allow severely disabled children to use eye selection for their symbols. Even where physical pointing is possible, it is often slow and inaccurate, requiring correction and amendment in the process of building up a message. No permanent record is kept unless the teacher laboriously transcribes one, and even then it is unlikely to be in Bliss form, but rather a written text inaccessible to the child. The result is a labour-intensive task for both parties.

Blissapple, described elsewhere by Odor and Vanderheiden (1981)(6), is a set of programs for the Apple microcomputer which allows Bliss symbols to be selected from a user-specific set, displayed on a TV screen and accumulated there into a message. This can be edited if need be, and printed in Bliss symbolic form on a commercial printer. The programs are capable of accepting a variety of input devices, allowing a school to devise selection systems which are appropriate to the needs of a particular user and to be assured of an easy connection to the microcomputer, with no software modification. With such a system, a pupil could be encouraged to work more independently, and could create Bliss-form permanent records of her efforts. The program is well written and cheap (ie, about £20).

Any teacher wishing to use this Bliss Apple system, must first know that it exists, and then discover what its capabilities are. This is no small task, as the program is not distributed by any software house which is typical of aids programs, and in addition, its use requires careful forward planning. She must assess her children and arrange for suitable interfaces and input devices to be bought off the shelf, if possible, or to be designed and made which is more likely. She must acquire the Blissapple program and documentation and learn how to use it, training her colleagues in the process. Finally, she must design schemes of work which integrate the new facility into her teaching practices, and begin to use the system in the classroom. Since the facility is novel, she will need to evaluate the results carefully. To do this effectively she will need links with workers elsewhere using similar systems.

In short, to make the best use of this aid the teacher needs much more than just money; she needs technical support of a kind not currently available in schools. This support should include initial information about systems; demonstrations and training facilities; local technical and possibly programming help, research and development contacts and, most importantly, a recognition that such development work takes time, effort, and needs appropriately allocated school resources. It cannot be undertaken as a spare time activity.

Unfortunately, although some money has been allocated by the Microelectronics Education Programme to this work, it looks as though this will merely highlight the need rather than offer the solution.

● further problem might be that the LEA has only bought one particular type of machine, and that the required software is not available for this machine. There is a strong argument for letting software requirements dictate the choice of hardware when few good software products are available.

5 Helping the physically handicapped

Physically handicapped children can use microcomputers in their leisure to play games; as a text editor to prepare written work; and as a means of accessing a variety of computer-assisted learning programs. If we take the case of a teacher who wishes to use a microelectronic device to enable a physically handicapped child to access CAL programs, there will be a number of problems to overcome. One approach is to adapt the software so that it can be accessed directly. Where the effects of the handicap are similar, eg, with blind children, there is some sense in this approach, as the need, in this case for a sound output, will be uniform. However, with physically handicapped children the remaining abilities are unique to each child and the ideal communication aid should be modifiable so that s/he can make the best use of it. This is achieved by separating the communication aid function from the teaching function. Leaving to one side the problem of finding good educational software, the teacher requires an aid that can be easily tailored to the individual. It should give the user a choice between single or multiple switches, using muscle potential, eyelash flick, suck and blow, tongue movements, or other means of control. The ideal ergonomics for each mode of input will vary: the tracking may need to be smooth or stepped; the speed will need to be adjustable, etc.

Each new facility adds complexity to the system. For this reason, and because of economic constraints, many aids designers have chosen to base their systems on the lowest common denominator, the single or multiple switch-controlled menu system, even where the user has other remaining abilities which could be exploited. For instance, many operators of limb-controlled switches can grunt or shout, although perhaps not at a time precise enough for tracking purposes. A truly tailorable system should exploit this in a natural way, say, as a 'rubout' key. Currently, few do. In addition, the communication aid should be portable, ie light, small and not dependent on mains electricity.

The teacher is unlikely to find a portable, tailorable aid that will interface with the micro running the program and act as a surrogate keyboard. The portability problem should be solved by hardware developments, but fully tailorable aids will only result from a substantial research investment. The problem of defining interfacing standards could best be achieved by a major initiative, possibly from a Government department. All microcomputers running CAL or word processing programs should be accessible to a physically handicapped person using a communication aid, just as all public buildings should now be accessible for wheelchair users.

Activities funded by MEP

In July 1981 the Microelectronics Programme Advisory Committee recommended, in principle, the funding of a number of activities in the area of microelectronics and special education. In August 1981 CET was asked to coordinate these. At the time of writing few of the details have yet been agreed. We hope that the next edition of this information sheet will give more names, addresses and telephone numbers.

1 Curriculum Development

Under the MEP, curriculum development is regionally based and the majority of special education work will be organised in this way. See the MEP Strategy paper for further details(3). As the proposals for regional curriculum development are generated by LEA representatives, it is essential that those advocating special education work should make their views known to the appropriate regional committee. It is envisaged that the total funding for this work will not exceed £120,000 per annum (ie, the equivalent of three regions-worth). In October 1981 the only region to have decided to carry out curriculum development in special education is the West Midlands region.

The project will commence on 1 January 1982 and be based at Four Dwellings School, Dwellings Lane, Quinton, Birmingham. The project leader will be Mrs Myra Duffy and her deputy will be Mr Michael Trott.

The aim of the project will be to develop materials for perceptual development. Further details are not yet available.

There will be some support for 'one off' projects but these will be low cost and the total allocated to this category is unlikely to exceed £30,000 per annum. One project approved by DES in this category is the production of computer managed learning materials for the implementation of individualised curricula in ESN(S) schools. This is being carried out by Dr Colin Robson at Huddersfield Polytechnic. The result of the project will be an "Implementation Pack" for schools and other institutions wishing to use a microcomputer to assist in implementing an individualized structured curriculum for children with special needs. The pack (tailored to 380Z and BBC "Acorn Atom" systems) will include system specification, software (both in case study and general forms) and teacher training handbooks. Please note, however, that it will not be available until December 1983.

Other possible areas are the development of some programs for the deaf, for ESN(M) children, and for the user of a concept keyboard. Details are not yet available.

2 Teacher Training

Teacher training at the familiarisation level will continue to be organised by LEAs, and through MEP's Regional Information Centres and Special Education Microelectronics Resource Centres (SEMERCs). Short specialist courses of one week's duration will be funded by MEP. These will aim to provide users with a deeper appreciation and understanding. There will be 11 one-week courses organised during the remaining 2½ years of the Programme. £10,000 is allocated for the preparation of teacher training materials in 1981 and 1982.

A course for teachers, other staff and parents of physically handicapped children will be held at Castle Priory College, Wallingford, Oxon. on 19 - 23 April 1982. Entitled "How microelectronics can help in the education of physically handicapped children", it will include demonstrations of a variety of devices; looking at operating and teaching programs; and consider the use of the microcomputer in supporting a wide curriculum. The integration of micros with other equipment, such as tape recorders and slide projectors, will be covered, and time will be given to considering how teachers specify their programming needs and evaluate programs.

The cost will be £35.

There will be a course for teachers of children with learning difficulties from 22 - 26 February 1982 in Chorley, Lancs. The course is intended for teachers, advisers/inspectors and parents who have initial experience of microcomputers (ie it is not a beginners course). It will consider educationally effective applications of microcomputers for children with learning difficulties with some attention to communication devices for those with communication problems.

Application forms and details for both of these courses are available from Mrs A Anderson at CET (or phone 01-977-8045).

The work on teacher training is being managed by Mr C A Nichols, who can be contacted at CET.

3 Special Education Microelectronics Resource Centres (SEMERCs)

The SEMERC will be responsible for:

a Promotion and Liaison

- i) The SEMERC will promote the effective use of microelectronics in the teaching of children with special needs in its region. It will actively reach out to those working with children with special needs, and use a wide variety of methods to contact teachers and parents.
- ii) It will make links with all relevant voluntary and statutory institutions and individuals in the region including special schools, academic institutions, REMAP groups, aids centres coordinated by the Disabled Living Foundation, LEA special education advisers and HMIs.

b Information

It will provide information on:

- appropriate hardware and software for children with learning difficulties
- communication aids - types, availability, funding and appropriateness
- software that can be accessed via communication aids
- local institutions which will support the tailoring of individual - communication aids and the modification of software
- appropriate training courses.

It will collect information on:

- statistics of use.
- acquisition (of hardware and software) difficulties
- tailoring difficulties
- resource usage problems (eg, inappropriate materials, inappropriate teaching styles)
- the need for new aids.

(In the short term only) it will act as a software distribution centre for the region.

c Teacher training

It will encourage teacher training institutions in the region to include an awareness of microelectronics in special education in initial teacher training courses, and more detailed coverage in post-experience courses for special education teachers. SEMERCs will work with LEA special advisers to implement appropriate local in-service courses.

MEP will provide four such centres. All centres will have a regional responsibility for slow learners and children with learning difficulties, and, in addition, each will have a national interest in either the blind; or the deaf and children with language impairment (including dyslexia); or the physically handicapped; or ESN(S) and autistic children.

The control of the centres will be separate from that of the 14 regional information centres also being set up under MEP, but appropriate co-ordination between the two types of centre will be developed.

Decisions about the SEMERCs have not as yet been finalised so addresses cannot be given. It is hoped that they will be operational early in 1982.

4. Consultancy on communication aids in education

Two consultancy centres will be set up to advise physically handicapped schools on the use of microcomputers as communication aids. One will cover Wales, Northern Ireland and the north of England, the other the south. These will start from 1 January 1982 and the consultants will be

- 1) North of Birmingham - Mr P Odor, Godfrey Thomson Unit, University of Edinburgh, 24 Buccleuch Place, Edinburgh EH8 9JT
- 2) Birmingham and the South - Mr A Tolleyfield and Mr P Poon, Electrical Engineering Department, Kings College, The Strand, London WC2R 2LS.

It should be stressed that the MEP funding for this Project is limited and these consultants are only employed for a small fraction of their time on this work. The coverage will not therefore allow for a fully comprehensive service to schools. We hope however that it will be both a practical service to schools and also a means whereby MEP can become aware of the uses of micro-electronics in the education of physically handicapped children.

5 Investigation Proposals

Two areas of investigation will be supported: (1) the problems of access of the physically handicapped and blind children to CAL programs, and (2) the related problem of input devices for severely physically handicapped children with special needs in the communications field.

Kirkby Springfield School, Cawthorn Close, Kirkby, in Liverpool is investigating input/output devices for the physically handicapped and is to prepare some software. This will not be available until mid 1982.

6 Newsletter

A special education issue of ACE (Aids, Communications and Electronics)(8) will be distributed to special schools and LEA advisers in the autumn term.

7 Small Devices Fund

A sum of no more than £20,000 will be available for the development, production and investigation of small devices which have particular educational relevance. Possible projects in this category are the production of some micro-electronic devices for ESN(S) children and an investigation into the use of speech synthesis with children with learning difficulties.

8 Central Coordination

CET has been asked by MEP to coordinate work in this field. The CET member of staff responsible is Mary Hope, who will be working closely with Mike Bostock, the MEP member of staff responsible for special education.

The directory

The most frequent requests are for information about software availability and who is working in particular areas of special education. To try and answer these, the attached directory of "Who's doing what" has been prepared. This is a pragmatic solution to a problem, and so it is important to stress that the programs listed have not been evaluated. CET is unable to vouch for their educational usefulness.

References and further reading

1. CET Information Sheet 1 - "Thinking about Microcomputers - First Steps - available from CET (3 Devonshire Street, London W1N 2BA)
2. Paula Tansley and John Panckhurst: Children with Specific Learning Difficulties (The Nelson Publishing Company) ISBN 0 85633 216
3. Seymour Papert: Mindstorms (Harvester Press, 1981) £9.95 ISBN 085527 1639
4. Anthony P Mullan: Extending the Interactive Period (Windfall, October 1981)
5. Mike Thorne: Computer Programs for Education - Are we on the right track? (Practical Computing, January 1981)
6. Phil Odor and Greg Vanderheiden: An Introduction to Blissapple (ACE, Vol.1, Issue 3, 1981)
7. Microelectronics Education Programme: The Strategy available from Publications Despatch Centre, DES, Honey Pot Lane, Canons Park, Stanmore HA7 1AZ
8. ACE - Aids, Communication and Electronics - published by the Group for Technology and Disability. Details from Peter Deakins, Neath Hill Professional Workshop, 1 Fletchers Mews, Neath Hill, Milton Keynes
9. CALNEWS - available free from CET.
10. CETNEWS - available free from CET.
11. Paul E Goldenberg: Special Technology for Special Children (University Press, Baltimore)